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MINISTRY OF SUPPLY

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

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13 JUN 1953

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

Marathon 1 VX. 229
(4 Gipsy Queen 71)

A.S.I. and Altimeter Pressure Error Corrections

A. & A.E.E. Ref: AAEE/5711/P2
M. O. S. Ref: 7451/11/RDAC2,
Period of Test : 8.7.52

Progress of Issue of Report

Report No.	Title
8th Part of AAEE/840	G-AMDH - Measurement of distances for take-off and landing and accelerate stop distances.
9th - do -	G-AMDH - Climb performance.
10th - do -	G-AMDH - Brief handling assessment.
11th - do -	VX.229 - Handling trials at the aft C.G. limit.
12th - do -	VX.229 - Handling trials at the forward C.G. limit.

Summary

A Marathon 1, serial number VX. 229, was sent to this Establishment for brief handling trials before acceptance by the R.A.F. for use as a Navigational trainer aircraft.

As part of the programme of tests, the A.S.I. pressure error corrections were measured separately as static and pitot, for the first pilots A.S.I. only, in each of three aircraft configurations at approximately constant weight. The altimeter pressure error corrections were derived from the measured A.S.I. static pressure error corrections.

This Report gives curves for pitot, static, and combined pitot-static pressure error corrections at sea level calculated, from the measured values for all up weights of 17,100 lb., 15,200 lb., and 13,300 lb. in each of three aircraft configurations. The effect of altitude was calculated for a height of 15,000 feet and the variation from sea level results found to be negligible. The sea level curves are therefore considered to be applicable for all heights up to 15,000 feet.

The corrections and also the variation over the speed range, are large and exceed the AP. 970 requirements of Chapter 726. The corrections also vary ^{with} aircraft weight and configuration. Bearing in mind the intended Service role of this aircraft, it is recommended that the A.S.I. system be modified to bring the pressure error corrections within AP.970 limits.

Although the correction has not been measured during a manoeuvre producing a yawed state of the pressure head, it is expected that this would result in large corrections, particularly in the configuration of undercarriage down. It is recommended that the correction be assessed experimentally if it should be decided to waive the requirement of AP.970, and then retain the A.S.I. installation as tested on this aircraft.

/The.....

The altimeter pressure error corrections are, for all altitudes up to 15,000 ft., within the AP. 970 requirements and are such that the altimeter indicates heights lower than the true pressure heights.

This Report is issued with the authority of



Air Commodore
Commanding A. & A.E.E.

1. Introduction

Marathon 1 VX. 229 was sent to this Establishment for brief handling trials, to assess its suitability for use by the R.A.F. as a Navigational trainer aircraft.

As part of the programme of tests, the A.S.I. pressure error corrections were measured separately as static and pitot, for the first pilots A.S.I. only, in each of three aircraft configurations at approximately constant weight. The altimeter pressure error corrections were derived from the measured A.S.I. static pressure error corrections. This Report contains curves for pitot, static and combined pitot-static pressure error corrections, and for the altimeter pressure error corrections.

2. Condition of Aircraft

2.1 General. The condition of the aircraft was exactly as described in the 11th part of this Report.

2.2 A.S.I. system. The first pilots A.S.I. was connected to a Mark 8 D^M pressure head mounted on the port underside of the fuselage nose. All airspeeds quoted in this Report refer to this A.S.I. A venturi pitot head Mark 1, was mounted opposite the Mark 8D^M head on the starboard underside of the nose. This was used only to determine the pitot pressure error of the first pilots A.S.I. system. Details of the A.S.I. system and pressure heads are given in Figure 1.

2.3 Loading. The tests were made after taking-off at 18,000 lb, the maximum permissible weight for take-off and landing.

Details of the loading are -

Weight lb.	Centre of gravity position in inches aft of the datum point and percentage of S.M.C.			
	Undercarriage down		Undercarriage up	
	Inches aft of datum	Percentage S.M.C.	Inches aft of datum	Percentage S.M.C.
18,000	37.1	31.5	36.5	30.8

The design centre of gravity range, undercarriage down, was from 24.74 inches to 37.06 inches aft of the datum point (i.e. 18.0% to 31.4% S.M.C.)

3. Tests made

The static pressure error of the first pilots A.S.I. was measured in level flight, near sea level, by the aneroïd method covering a speed range of 60 - 180 knots I.A.S. The pitot pressure error of the first pilots A.S.I. was also measured, in symmetric powered flight at a height of about 3,000 feet, covering the same speed range.

The tests were made after taking-off at 18,000 lb., the maximum permissible weight, in the three following aircraft configurations:

- (i) Flaps and undercarriage up.
- (ii) Flaps take-off (18° down), undercarriage up.
- (iii) Flaps fully down, undercarriage down.

4. Results of tests

4.1 General. The methods of A. & A.E.E. Report Res/244 were used to evaluate the pressure error corrections and estimate the effect of weight and altitude on these corrections. The calculated effect of altitude for height

/up to.....

up to 15,000 ft. was found to be negligible, the result at sea level found in this part of the Report, apply therefore to all altitudes up to 15,000 ft.

Included in Report Res/244, is the scale-altitude relation, which must be allowed for when evaluating the equivalent airspeed from the pressure error corrections given in this Report. When using the results of this part of the Report with instruments that have a complete or partial corrective mechanism for the scale-altitude term, the extent of the correction applied to the instrument must be ascertained before allowing for the scale altitude correction.

4.2 Static pressure error correction. The results of the static pressure error measurements are given in Fig. 2 corrected to aircraft weight of 17,100 lb., 13,300 lb., and 15,200 lb. These represent 95% of the maximum permissible weight, the maximum permissible weight less 95% of the weight of fuel and other disposable load, and a mean of the former two weights respectively. The first two of the above weights, are considered the extremes likely to be met in service.

4.3 Pitot pressure error correction. The results of the pitot pressure error measurements given in Figure 3, are corrected for the three aircraft weights listed in para. 4.2 above. The values measured for each of the three aircraft configurations were very similar, and a mean line drawn through each set of points, when plotted as V_R knots v. P.E.C. knots, showed the three curves to be almost identical. The pitot pressure error correction for the three configurations has, therefore, been represented by one line for each of the three weights.

4.4 Pressure error correction. The A.S.I. pressure error correction, obtained by combining the A.S.I. static and pitot pressure error corrections, is plotted in Figure 4 for each of the aircraft configurations and weights.

4.5 Altimeter pressure error correction. The altimeter pressure error correction curves, given in Figure 5, were derived from the A.S.I. static pressure error measurements, and have been calculated for sea level, 5,000 feet, 10,000 feet and 15,000 feet. They are quoted for the flaps and undercarriage up configuration and the mean of the weights, 15,200 lb., only.

5. Discussion of results

5.1 Comparison with results obtained by the Firm. The results obtained with flaps and undercarriage up were compared with those obtained by Messrs. Handley-Page (Reading) from tests made on a Marathon aircraft fitted with a nominally identical pressure head and A.S.I. system, under similar conditions of weight and power appropriate to level flight at relevant conditions. The A.S.I. pressure error corrections given in this Report, are practically the same as those obtained by the firm.

5.2 Pitot pressure error correction. It will be noted by reference to Figure 3, that there is a pitot error correction due to pitch, the correction growing from zero at 50 knots I.A.S. to about + 3 knots at 180 knots I.A.S. According to Figure 1, the pressure head is set parallel to the fuselage datum, and would be expected other factors being ignored, to record pitot pressure accurately at an aircraft speed much nearer the maximum. There is, therefore, little doubt that the pressure head is too close to the fuselage and is being influenced very largely by the change of direction of the velocity field, relevant to the fuselage nose, due to change of translational speed and hence pitch.

5.3 A.S.I. pressure error corrections with the head yawed. Although the effect of a manoeuvre introducing a yawed state of the head has not been investigated experimentally on Marathon VX. 229, it is thought that such a manoeuvre may give rise to very large pressure errors; this may be influenced by the degree of interaction between the pitched and yawed states.

/Furthermore.....

Furthermore, it is possible that similar manoeuvres made in the configuration of undercarriage down (where the nose wheel doors are also open), will give rise to even larger errors; the proximity of these doors to the head is shown in Figure 1.

On Marathon 1, G-AMDH, on which the pressure error correction was measured and reported in the 5th Part of this Report, the pitots and statics of the two pitot-static heads, are mounted either side of the nose, and were interconnected, forming a balanced system. Although, as in the case of VX.229, tests were not made to measure the pressure error during a manoeuvre producing yaw, it is contended that such a system will be more favourable under these conditions of flight.

5.4 Setting of the pressure head. The pressure error corrections may also be sensitive to differences in settings of the pressure head from one aircraft to another, or as the result of fitting a replacement head.

6. Conclusions and Recommendations

The values of A.S.I. pressure error correction for a height of 15,000 feet calculated from the sea level result, show the variation with height to be negligible. The results obtained near sea level, apply to all altitudes up to 15,000 ft.

In steady level flight, with flaps and undercarriage up, and symmetric engine power conditions, the A.S.I. pressure error correction at 17,100 lb. weight, varies non-linearly from +9.5 knots at 90 knots I.A.S. to +6.5 knots at 180 knots I.A.S. At lower weights, the A.S.I. pressure error correction is less by about 1 knot and 2 knots at 15,200 and 13,300 lb. respectively, and follow the same non-linear form as the curve for 17,100 lb.

These corrections exceed the AP. 970 requirements, (see note on Figure 4).

The pressure error has not been measured during a manoeuvre introducing a yawed state of the pressure head; it is thought that a large error will result from such a manoeuvre.

The altimeter pressure error correction, at the mean weight of 15,200 lb., at sea level was +60 feet at 60 knots I.A.S., increasing to +75 feet at 180 knots I.A.S. At 15,000 feet it was +95 feet at 60 knots I.A.S., increasing to 125 feet at 180 knots I.A.S.

The altimeter pressure error corrections are, for all altitudes up to 15,000 feet, within the AP. 970 requirements and are such that the altimeter indicates heights lower than the true pressure heights.

It is recommended that:-

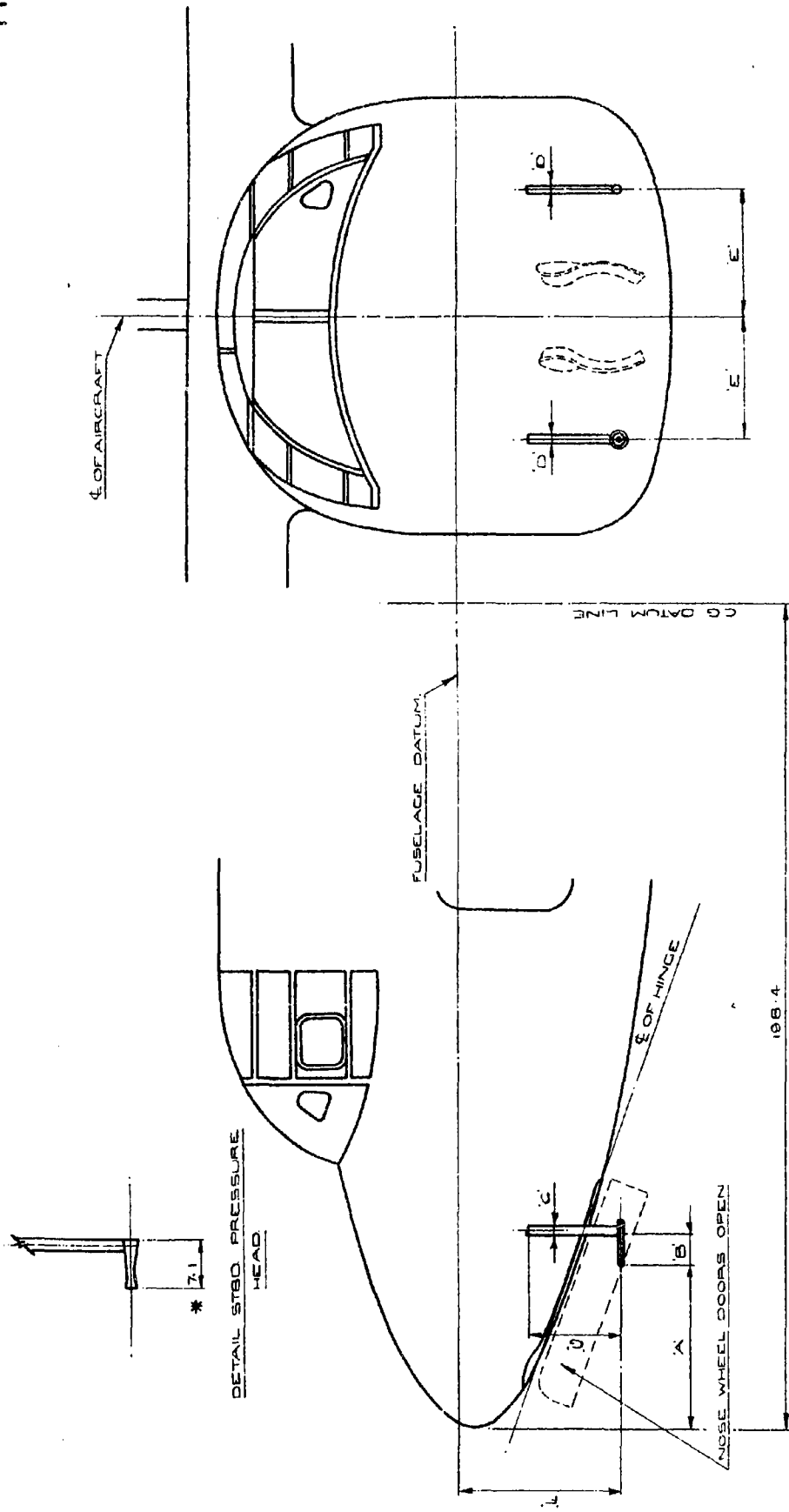
- (a) in view of the intended Service role of this aircraft, an alternative location for the pressure head should be investigated with the object of reducing the A.S.I. pressure error corrections to the limits called for by AP. 970.
- (b) if the A.S.I. pressure error corrections as measured in steady level flight are accepted, then the correction obtained during manoeuvres introducing a yawed state of the pressure head, should be assessed experimentally for this installation.

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ALL DIMENSIONS IN INCHES

FIG.1.



TYPE OF PRESSURE HEAD. PORT. MK VIII 'D'		STBD PV. MARK I	
		PORT	STBD
A	NOSE OF PRESSURE HEAD TO NOSE OF FUSELAGE (PARALLEL TO DATUM)	# 35.3	# 36.0
B	NOSE OF PRESSURE HEAD TO STRUT	# 5.7	# 5.1
C	MAJOR AXIS OF STRUT	# 2.0	# 2.0
D	MINOR AXIS OF STRUT	# 0.8	# 0.8
E	PRESSURE HEAD TO CENTRE LINE OF AIRCRAFT	# 26.8	# 26.8
F	NOSE OF PRESSURE HEAD TO DATUM LINE	# 35.8	# 35.8
G	NOSE OF PRESSURE HEAD TO FUSELAGE	# 17.0	# 17.0
THE PRESSURE HEAD AXIS IS PARALLEL TO THE FUSELAGE DATUM LINE AND CENTRE LINE OF FUSELAGE.			

DIMENSIONS MEASURED AT BOSCOMBE DOWN

DETAILS OF PRESSURE HEADS.

FIG.2.

SK.NVA 4224 1ST PART OF REPORT NGA&A.EE./B40 MARATHON I Vx 229 TR.D.L. CH, I.M. COLBORN APP 1.1.53

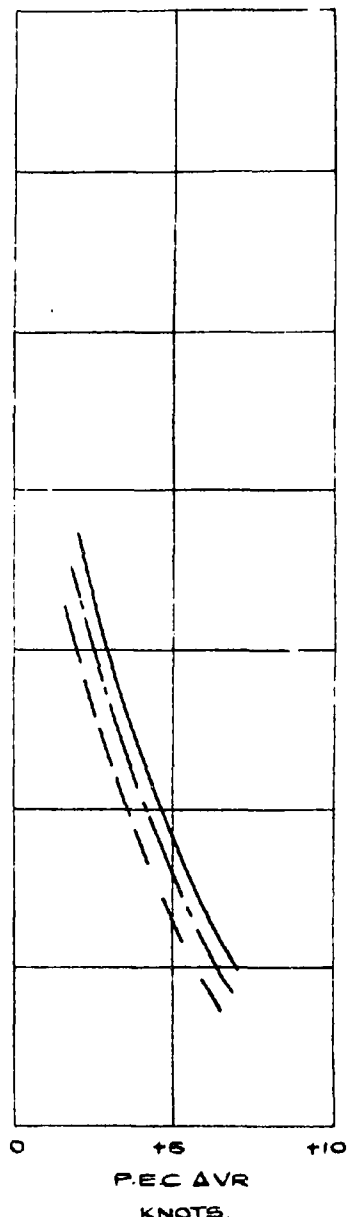
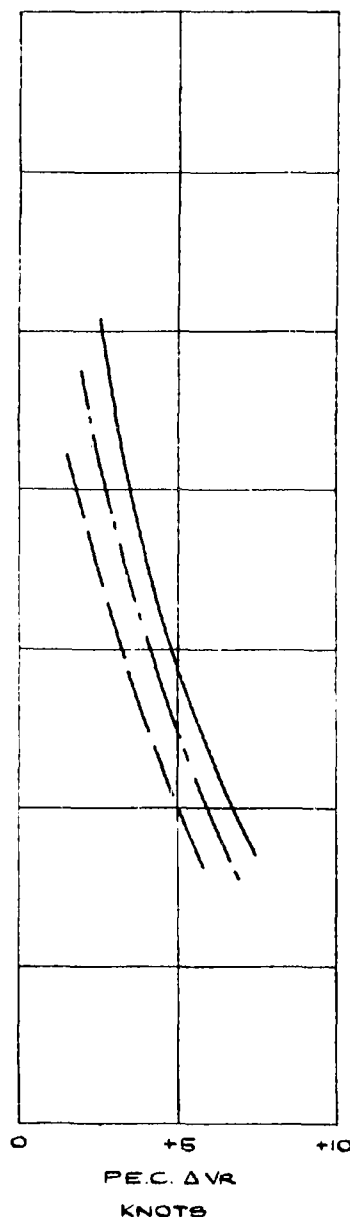
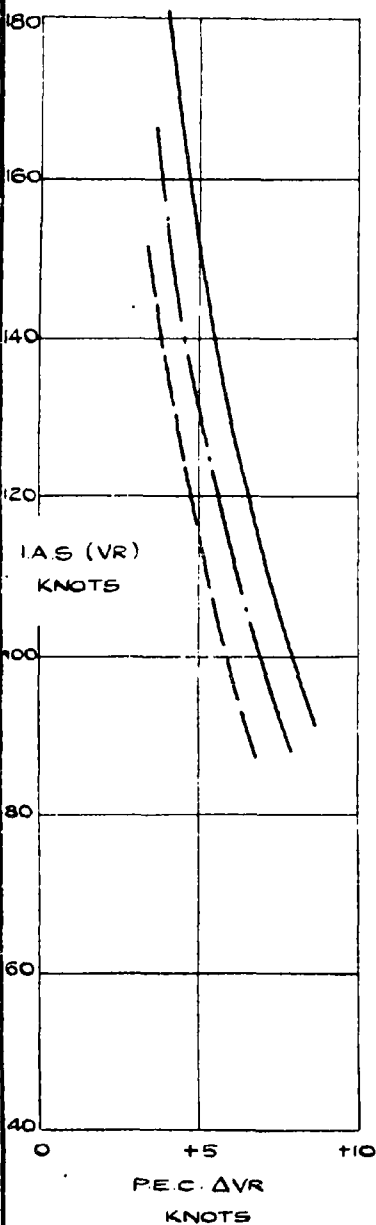
ALL ENGINES OPERATING.

- AIRCRAFT WEIGHT. 17,100 LB.
- · — · — AIRCRAFT WEIGHT. 15,200 LB.
- - - - - AIRCRAFT WEIGHT. 13,300 LB.

UNDERCARRIAGE
& FLAPS UP.

UNDERCARRIAGE UP
FLAPS 18° DOWN.

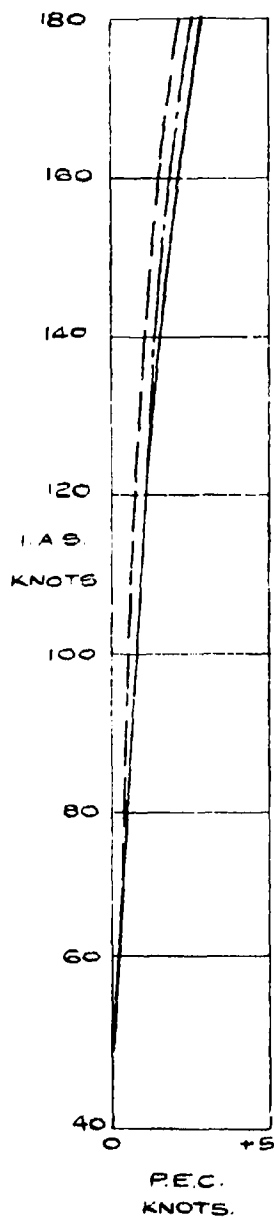
UNDERCARRIAGE
& FLAPS DOWN



A.S.I. STATIC PRESSURE ERROR CORRECTION.
FOR FIRST PILOT'S INSTRUMENT.

FIG.3.

———— 17,100 LB. AIRCRAFT WEIGHT.
 - - - - - 15,200 LB. AIRCRAFT WEIGHT.
 — — — — 13,300 LB. AIRCRAFT WEIGHT.



ASI. PITOT PRESSURE ERROR CORRECTION.
 FOR FIRST PILOT'S INSTRUMENT.

SK. No 4225 13TH PART OF REPORT NOA&AEE/840 MARATHON/ VX 229 TR. D.L. CH. I.M. COLBORN APP Rel. for Sof P I.I. 53

FIG.4.

SK. No. 4226 13th PART OF REPORT NO. A. E. E. / 840 MARATHON I VX 229 TR. O. L. CH. I. M. COLBORN. APP K. W. for SoP I. I. 53

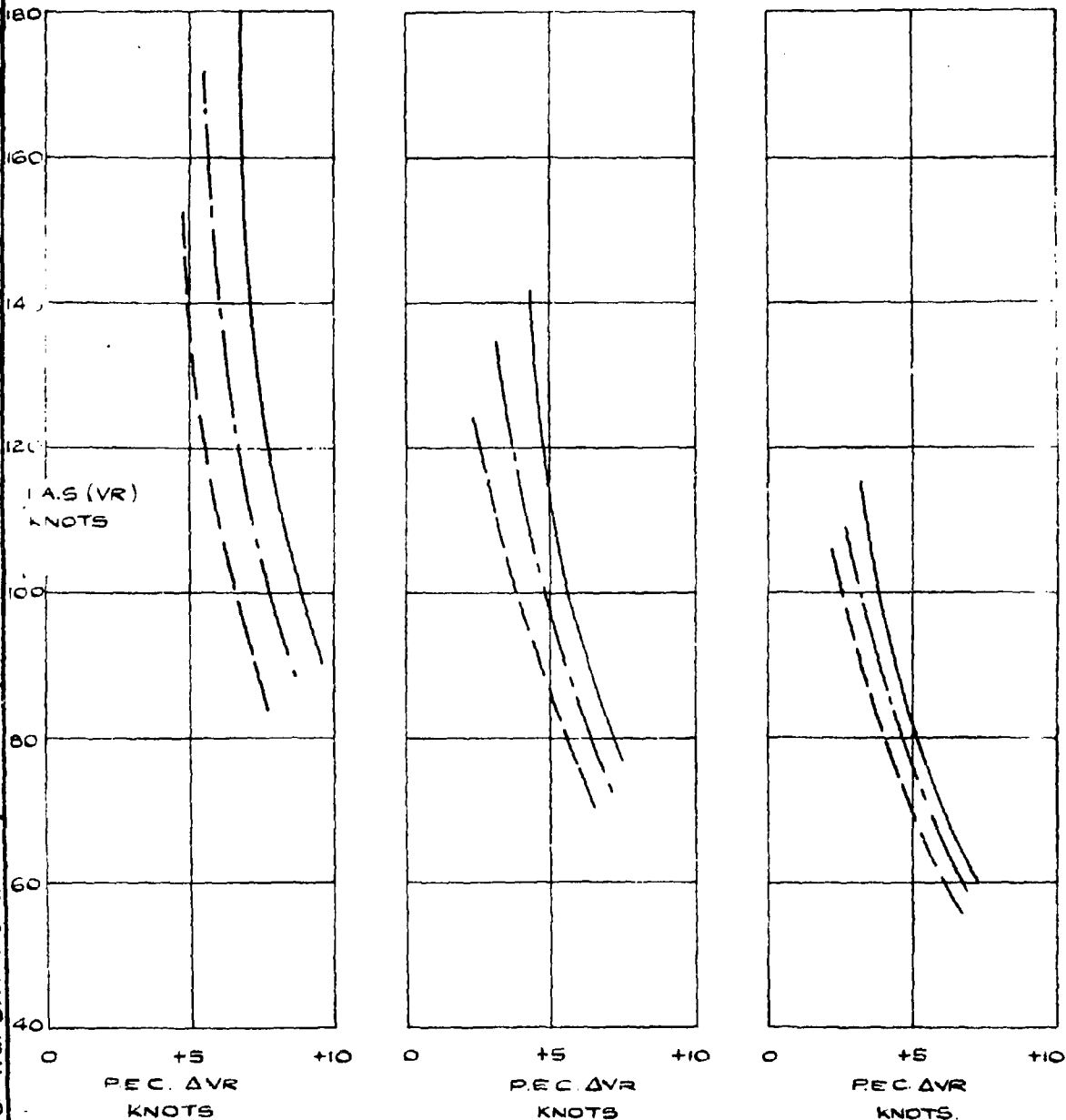
ALL ENGINES OPERATING.

———— AIRCRAFT WEIGHT. 17,100 LB.
 ———— AIRCRAFT WEIGHT. 15,200 LB.
 - - - - AIRCRAFT WEIGHT. 13,300 LB.

UNDERCARRIAGE &
FLAPS UP.

UNDERCARRIAGE UP
FLAPS 18° DOWN

UNDERCARRIAGE
& FLAPS DOWN.

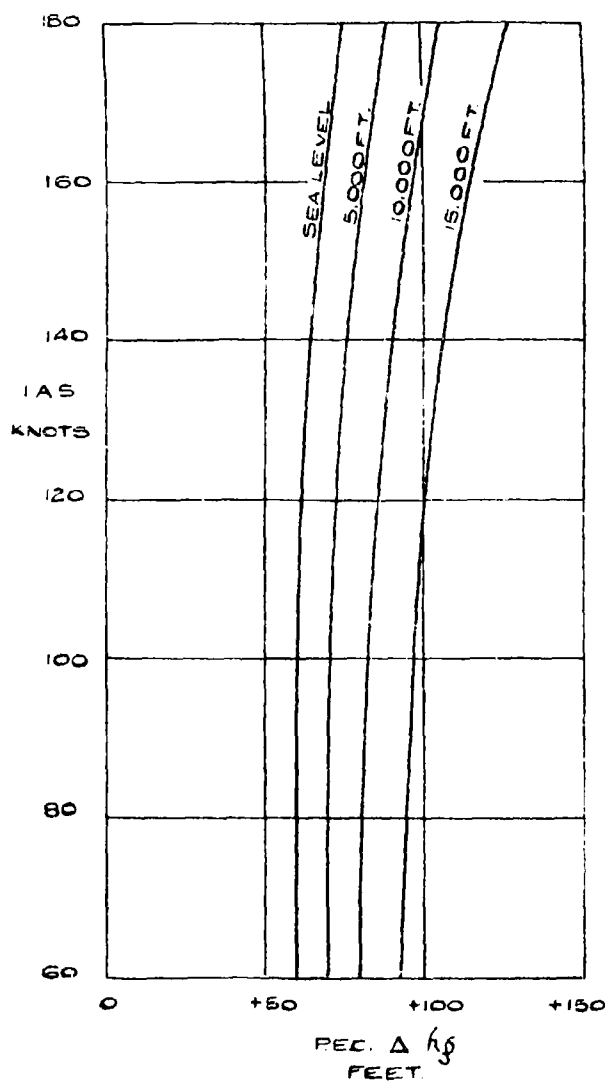


THE AR 970 REQUIREMENTS ARE THAT, OVER THE SPEED RANGE IN LEVEL FLIGHT, THE A.S.I. PRESSURE ERROR: (i) IS WITHIN ± 2.5 KNOTS, AND (ii) CHANGES BY LESS THAN 2.5 KNOTS WITHIN THAT BAND OF SPEED.

A.S.I. PRESSURE ERROR CORRECTION.
FOR FIRST PILOT'S INSTRUMENT.

FIG. 5.

ALL ENGINES OPERATING
FLAPS AND UNDERCARRIAGE UP.
15200 LB. AIRCRAFT WEIGHT



ALTIMETER PRESSURE ERROR CORRECTION.
FOR FIRST PILOT'S INSTRUMENT.



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